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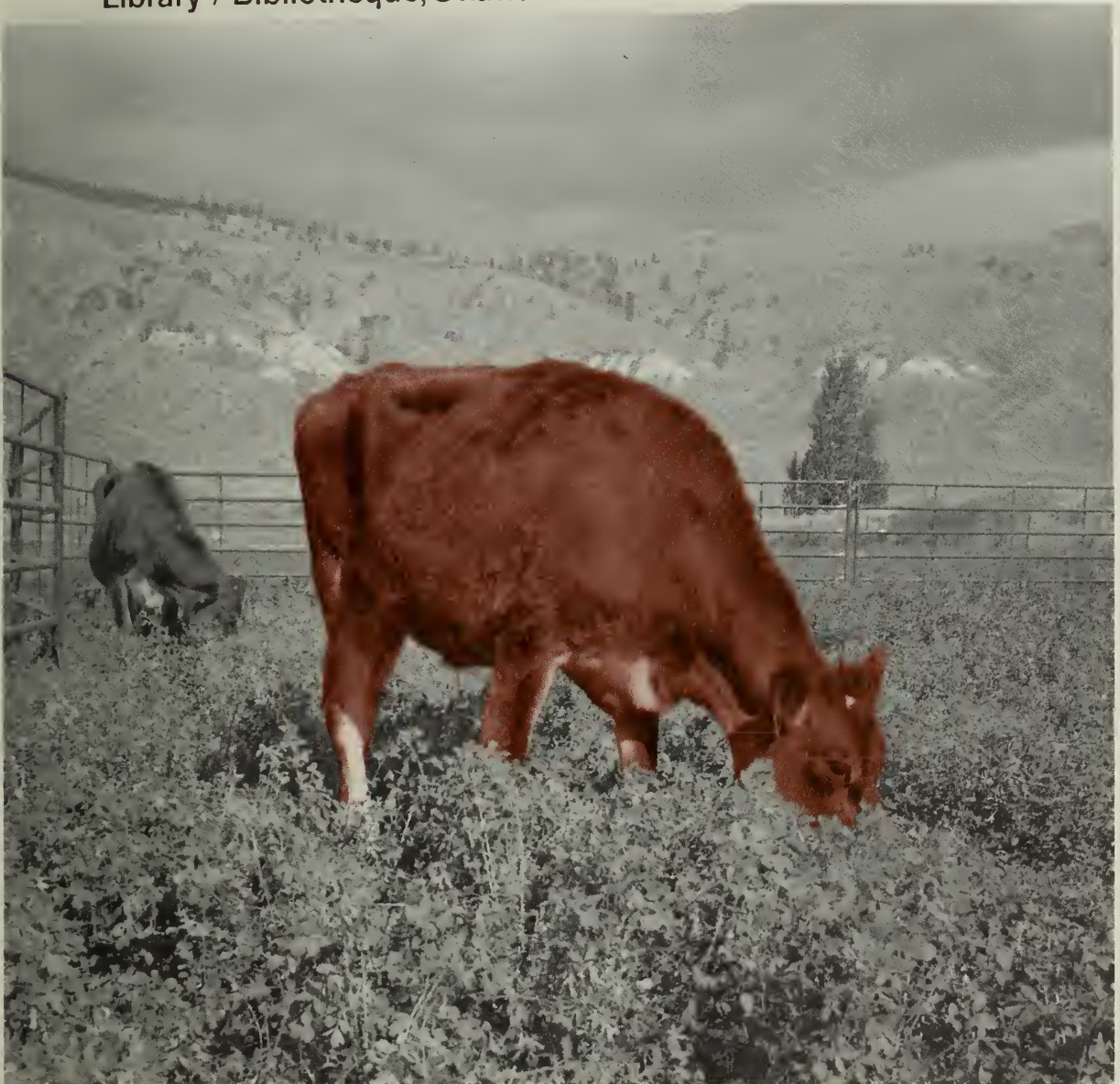
Bloat in cattle



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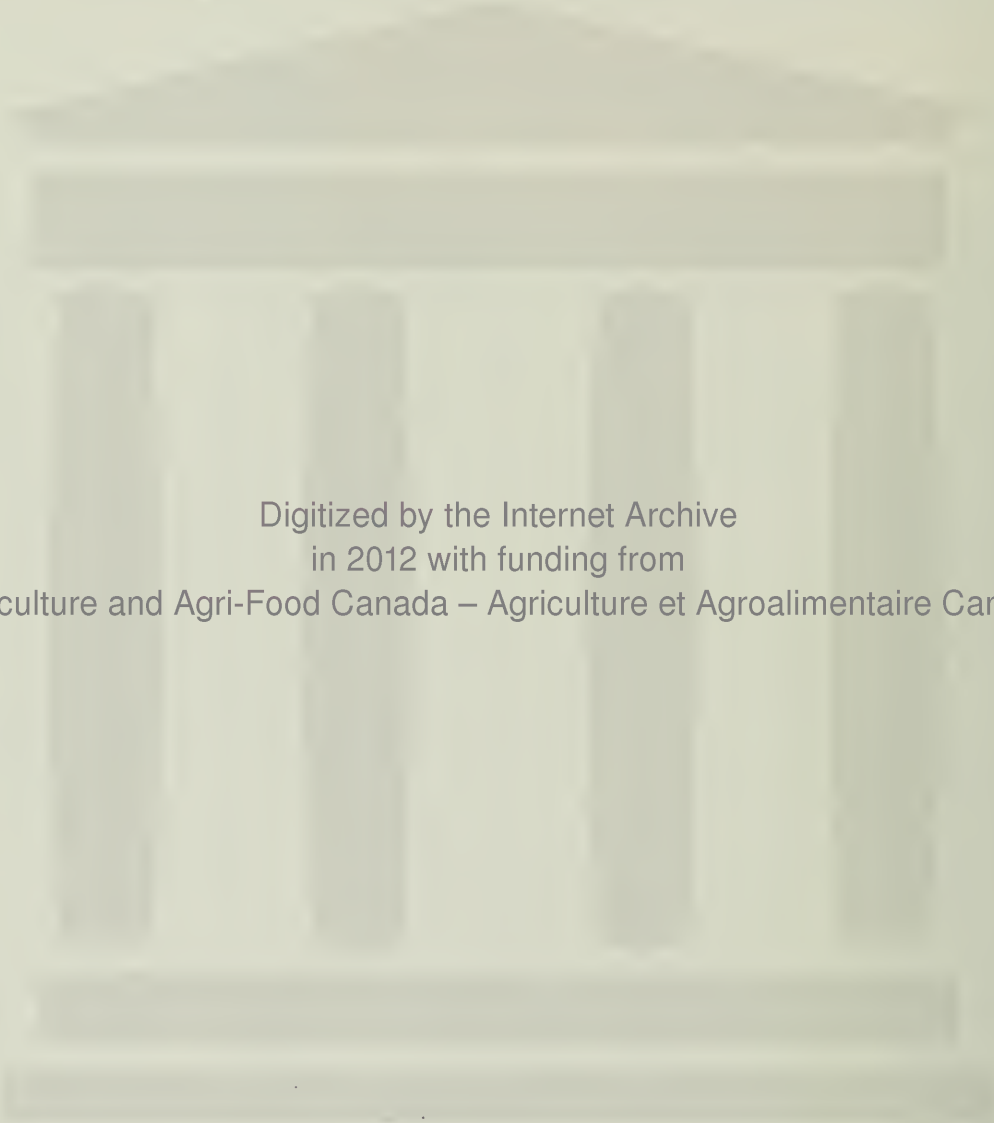
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Bloat in cattle

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Introduction

This publication provides information on the causes, control, and treatment of bloat in cattle and is intended for use by livestock producers, veterinarians, and agrologists.

The authors have broad experience from veterinary practice, research, and teaching. We have observed bloat produced under experimental conditions by feeding fresh alfalfa and bloat-causing feedlot diets. Although this publication is oriented toward livestock production in western Canada, the general principles are widely applicable and the publication should provide valuable information for other regions.

Bloat is a complex disease that is difficult to predict under field conditions. Consequently, field observations have led to varied and conflicting theories about its causes. This publication presents well-established facts and consistent field observations based on our collective experience. Recommendations are made on this basis and on research reports, general observations, and experience of cattle producers.

History

Bloat has been described in agricultural writings since at least A.D. 60. Few livestock diseases have such a long and colorful history. Names for bloat have changed over the years: hoove, hoven, tympany, and blown appeared in English journals of the 18th and 19th centuries. The French *météorisme*, meaning the process of ballooning, is still used to describe bloat.

In past centuries a bellyful of gas was attributed to a poison, to excessive gas production, or to blockage caused by the excessive consumption of dense feed. These and other explanations were the objects of experimental research in several countries from the 1940s to the 1960s. The frothy basis of pasture bloat was generally accepted only after vigorous debate and wide publicity of various and diverse theories in agricultural journals. Antibloat detergents (i.e., poloxalene) were developed during the same period. Eventually, animal nutritionists learned how to control feedlot bloat through diet formulation and care in feed processing.

A few recommendations from the past seem unusual today, e.g., "feathers burnt, and held for some time while in full smoke, close under the nose of the animal" (ca. 1795); and "a pint of gin to each animal" (ca. 1925). Some current practices have been used for many years. For example, placing an animal's front feet on a mound so that the front feet are higher than the back feet helped to ease bloat because the esophagus was thus elevated and the gas was expelled more easily. Enforced moderate exercise such as walking was a commonly used treatment for bloat and was often effective if used before bloat reached the acute stage. Another method involved placing a stick or rope through an animal's mouth to encourage salivation, which breaks down rumen foam. A book published in the early 18th century emphasized the need for care when cattle are first put into "clovergrass." In 1925 the London Society of Arts awarded a silver medal

for the design of a 4-inch (10-cm) trocar and cannula, instruments used for emergency treatment of severely bloated animals.

The incidence of pasture bloat increased around the world with the introduction of legume forages into cultivated pastures. Feedlot bloat came into prominence with the development of feedlot finishing of beef cattle.

Normal production and expiry of gas

Ruminant animals carry an active population of microorganisms (bacteria, fungi, and protozoa) in the forestomach of their digestive system. Without these organisms the animal would be unable to digest fibrous feeds, such as grasses and legumes. In the process of digesting these materials, the microorganisms produce large quantities of gas that must be expelled. When steers are fed fresh alfalfa, they produce up to 12–27 L/min.

Under normal conditions, the gas produced in the rumen separates from the solid and liquid contents and rises to the top of the rumen, where it collects as a free bubble (Fig. 1). Eructation, or belching, is initiated by increasing gas pressure in the rumen. When an animal belches the rumen contracts and pushes the free gas toward the front of the rumen, where it collects around the esophageal opening. The opening of the esophagus is controlled by receptors in the rumen wall that can sense when the area is exposed to liquid or to free gas. If the area is covered by liquid or foam, the esophagus remains tightly closed, preventing belching. This trait apparently has evolved in ruminant animals to prevent rumen fluid or foam from accidentally entering the lungs, which would cause aspiration pneumonia.

Eructation occurs when the receptors surrounding the esophagus sense that free gas is present. As the esophagus relaxes, the animal takes a deep breath, drawing the gas up the esophagus. Most of the gas (about 60%) then enters the lungs, and the remainder is expelled through the mouth. As most of the eructated gas enters the lungs before it is exhaled, it is difficult to notice or hear an animal eructate. If a large amount of gas is eructated, however, it is often noticed by a sound or a smell, or both.

Eructation, or belching, normally occurs about once every minute and requires about 10 s to be completed. The volume of gas produced by rumen fermentation increases after feeding and peaks in 2–4 hours. To accommodate increased rates of gas production, belching occurs more often, up to three or four times per minute. In normal animals the process is efficient in expelling large volumes of gas from the rumen.

Mechanisms of bloat

Bloat occurs when the eructation mechanism is impaired or inhibited and the rate of gas production exceeds the animal's ability to expel the gas. Since large volumes of gas are produced in the rumen, bloat can develop very quickly.

In both legume and feedlot bloat the eructation mechanism is commonly inhibited by frothy or foamy rumen content. The gas remains

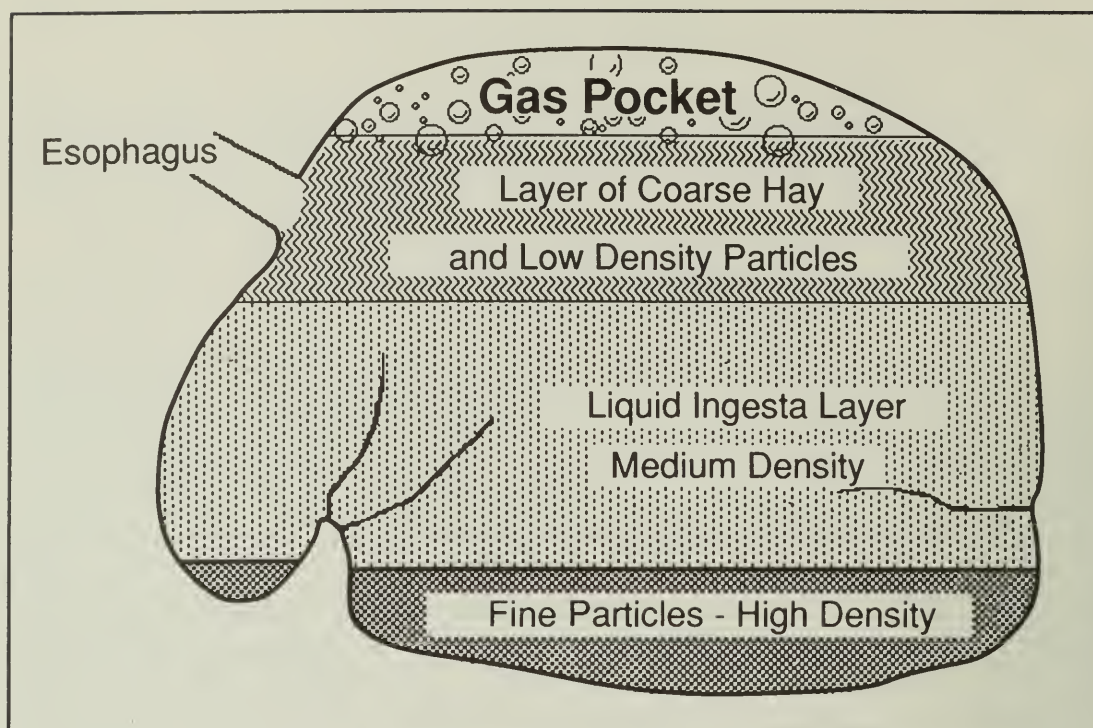


Fig. 1 Gas pocket above the various layers of rumen content.

trapped in the rumen fluid, forming an emulsion of small bubbles about 1 mm in diameter. The frothy rumen content expands, fills the rumen cavity, and inhibits the nerve endings that control the opening into the esophagus. This condition is known as frothy bloat.

Animals can tolerate moderate frothiness of rumen content without exhibiting bloat or they may expel enough gas from moderately frothy rumen content to recover from mild bloat without treatment. When frothy bloat is severe the pressure in the rumen eventually inhibits all ruminal contractions. This condition is called atony.

The existence of frothy and free-gas bloat can be determined by passing a stomach tube into the rumen. When the rumen content is frothy, the tube fills with froth and the gas cannot be relieved. When the animal is bloated with free gas, the gas pocket is usually easy to locate with the tube, and the expulsion of gas through the tube provides immediate relief from the bloated condition.

Frothy bloat

Although frothy rumen content is characteristic of both legume pasture bloat and feedlot bloat, until recently the physical and chemical explanations for the two conditions were quite different.

According to the traditional theory of legume pasture bloat, froth was attributed to soluble proteins in the rumen fluid, which were produced by legume forages. One protein, known as 18 S, or fraction 1 protein, initially received particular attention. The foaming properties of all soluble

proteins are well known. It was therefore reasonable to suspect them as the cause of pasture bloat. However, soluble proteins alone do not account for the extreme viscosity of frothy rumen content, since their concentrations in rumen fluid do not correlate with the occurrence of bloat in cattle that are fed fresh alfalfa.

Current theories place more emphasis on the involvement of small particles and microbial activity. Alfalfa, which is rapidly digested, also provides for bacterial blooms, producing large quantities of both gas and slime. Investigations with cattle that were fed fresh alfalfa at the Kamloops Research Station revealed an association between the concentration of small particles in the rumen content and the occurrence of bloat; the small particles are fragments of chloroplasts from the alfalfa. The rumen bacteria attached to these particles (Fig. 2) have an abundance of carbohydrates, both internal, in the form of storage granules, and external, in the form of slime. The occurrence of bloat is consistently associated with increased levels of these particles in the rumen fluid (Fig. 3).

Frothy feedlot bloat has been attributed to small feed particles in grain rations (Figs. 4, 5) resulting in slime (primarily polysaccharides) secreted by rumen bacteria and by polysaccharides released by ruptured bacteria. The bacterial slime and polysaccharides increase the viscosity of rumen fluid and subsequently trap small gas bubbles in the rumen fluid, leading to frothy rumen content and bloat.

These observations provide the basis for a unified theory of frothy bloat, which emphasizes the similarities between feedlot bloat and legume bloat (Table 1). The similar features are readily digested feedstuffs (diets high in grain and fresh immature alfalfa) and the abundance of small particles in the rumen content. Small particles and slime produce a frothy bloat complex when gas bubbles become trapped in the slime-particle mix.

Table 1 Similarities between feedlot bloat and alfalfa pasture bloat

Feature	Feedlot bloat	Alfalfa pasture bloat	Function
readily digested feedstuff	high grain ration	fresh immature alfalfa	energy source for bacterial growth and rapid slime and gas production
small particles in rumen content	fine grain particles	alfalfa chloroplast particles	small particles add to slime matrix
viscous rumen content	microbial slime	microbial slime	matrix to trap particles and gas

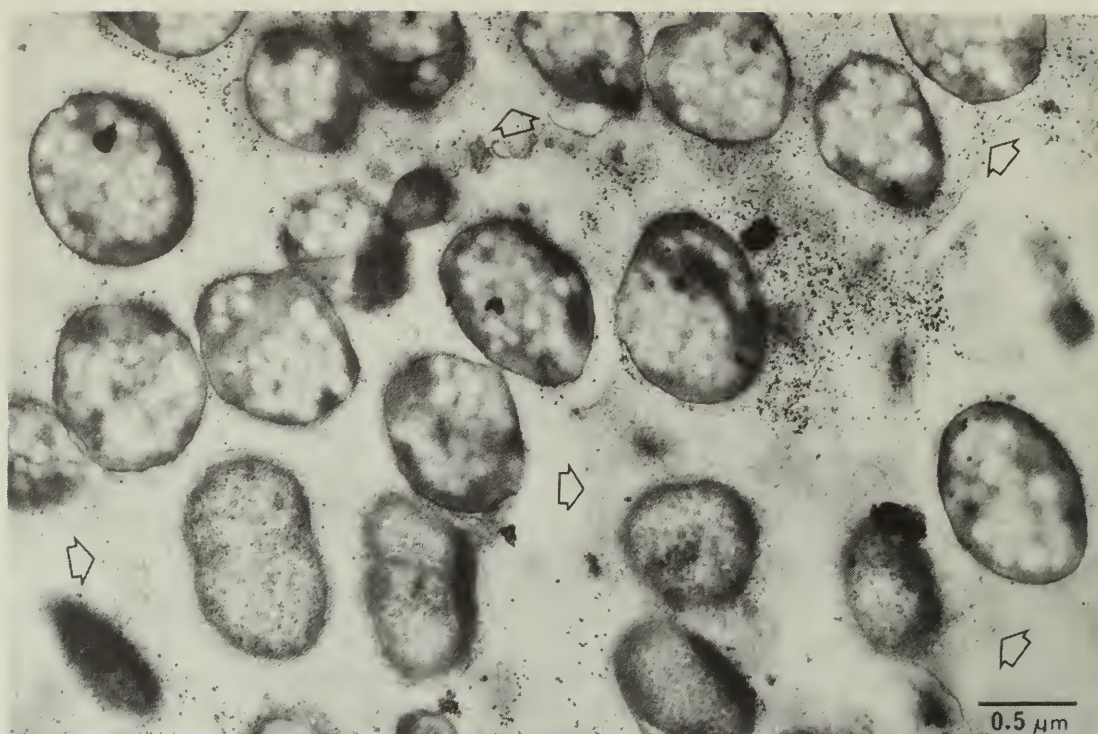


Fig. 2 Transmission electron micrograph showing the bacterial population of the rumen fluid of a cow affected by pasture bloat. Because of high nutrient availability, these organisms have produced copious amounts of slimy extracellular polysaccharides (arrows), which trap gas bubbles. They have also filled up their cells with spherical white reserve glycogen granules, which have a storage function.

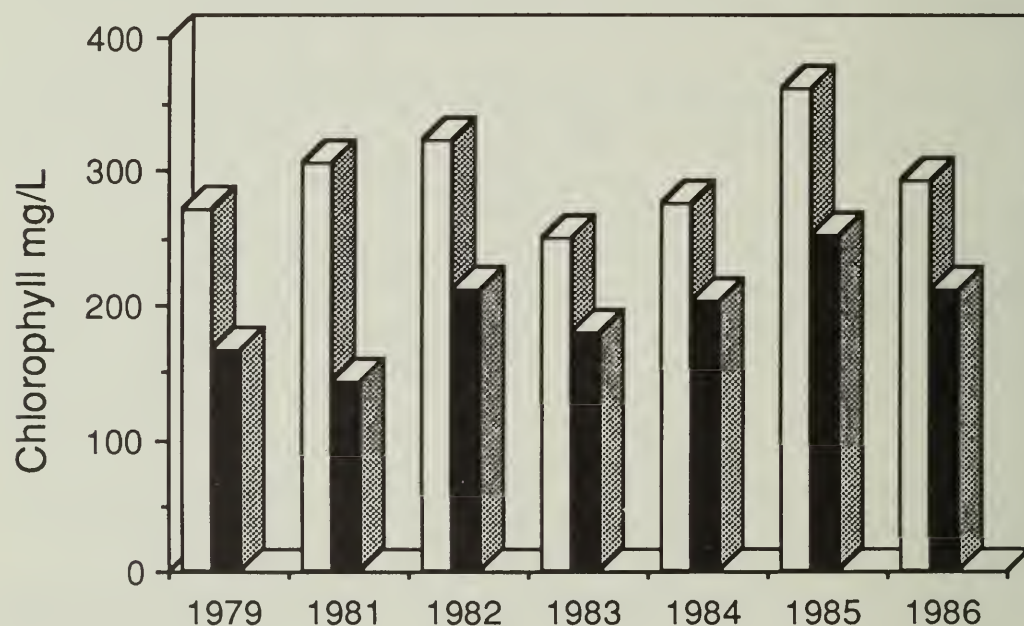


Fig. 3 Average concentrations of particulate chlorophyll in the rumen of bloating cattle (*open bars*) and nonbloating cattle (*solid bars*) before feeding. Data were not collected in 1980.

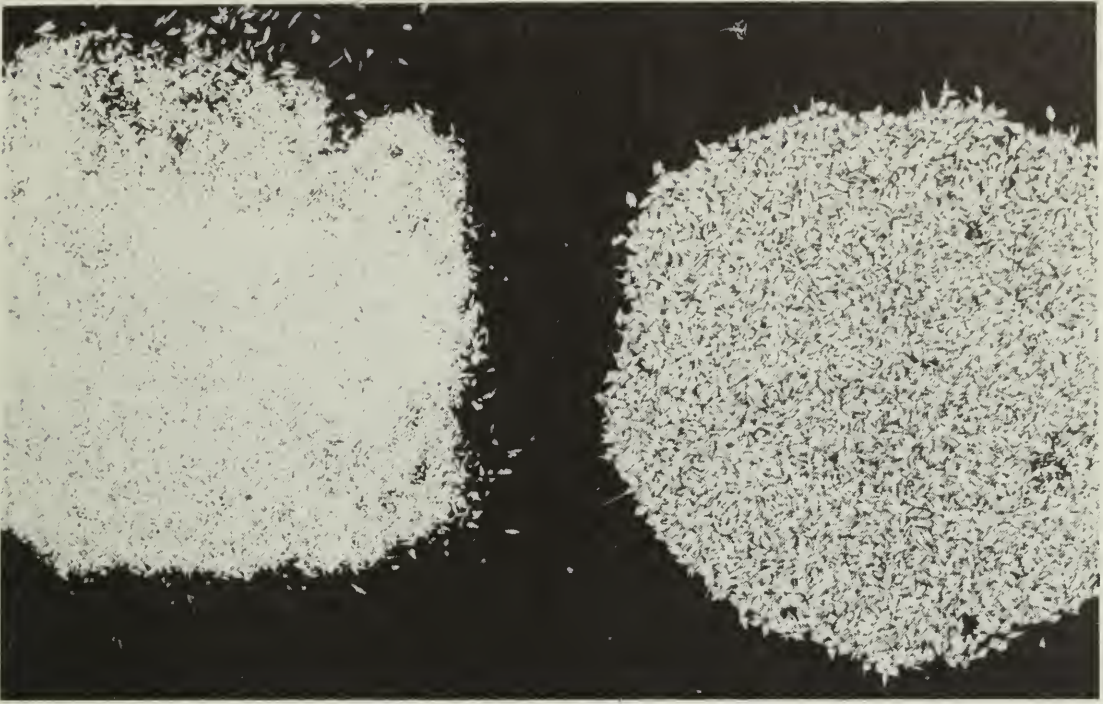


Fig. 4 Dry-rolled grain (*left*) is too fine and can cause bloat. Tempered and rolled grain (*right*) is coarse and free from dust.

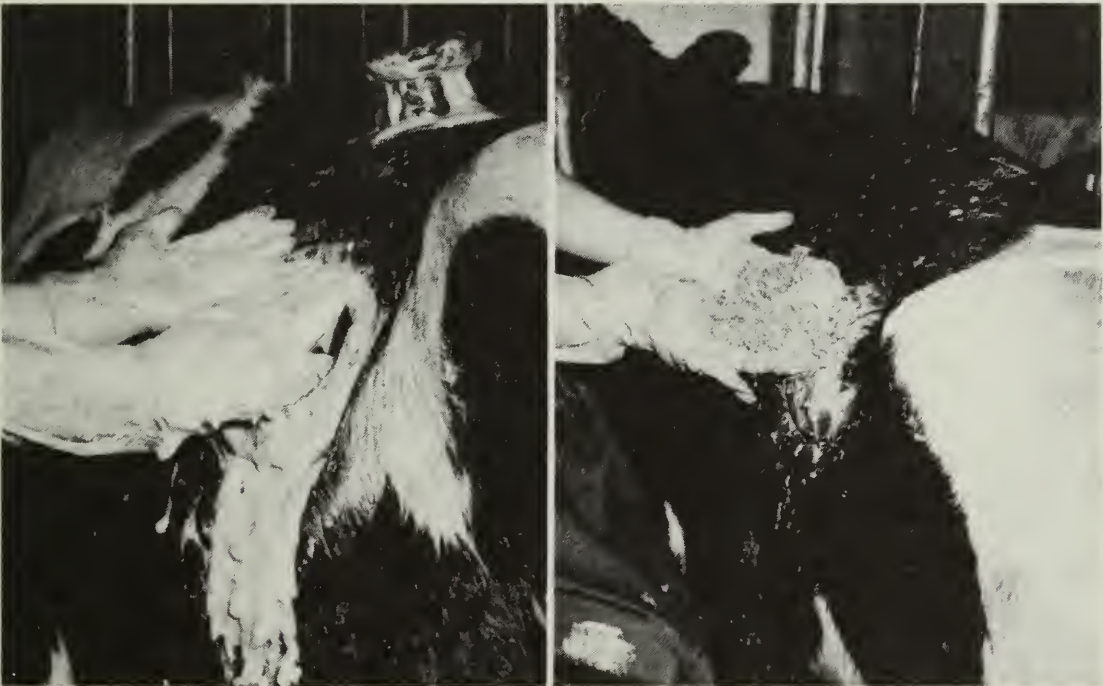


Fig. 5 Foamy rumen content from cows fed fine-particle feed (*left*) creates a potential for bloat. Rumen content contains no foam (*right*) when animal is fed coarse-particle feed.

These observations have led to a general theory of frothy bloat that attributes bloat to an excess of small feed particles in combination with readily digestible feedstuff. Our publication suggests strategies for the diagnosis and management of frothy bloat.

Free-gas bloat

Free-gas bloat in feedlot animals is more sporadic than frothy bloat, usually affecting a few animals rather than a large number. Free-gas bloat generally occurs very rapidly and provides little warning for treatment. Free-gas bloat accounts for approximately 10% of cases of feedlot bloat. Irregular feed intake, inhibition of the nerves controlling the contractions of the rumen walls, and physical obstruction of the esophagus may cause free-gas bloat.

Irregular feed intake may occur as a result of uneven feeding intervals, illness (such as a mild grain overload), changing weather, a change in the diet, unpalatable feed resulting from spoilage, or an interruption in the supply of salt or water. Excess acidity in the lower gut can inhibit rumen movement. If rumen movement is inhibited as a result of grain overload or for any other reason, free-gas bloat might develop.

The vagus nerves, which connect the rumen wall to the central nervous system, pass alongside the esophagus in the neck of the animal. Upon reaching the rumen, they branch out and spread over the rumen surface. When functioning properly, these nerves convey information from the nerve sensors in the rumen wall to the brain centres and transmit signals from the brain for the control of the muscles in the rumen wall. If the vagus nerves are damaged, information transferred to and from the rumen can be impaired. Depending on the severity of damage, rumen function can be affected to various degrees. Mild damage may not be visibly expressed in an animal, whereas severe damage may cause an animal to suffer from chronic bloat, feed impaction, lack of appetite, or a combination of these symptoms.

The cause of nerve damage or vagal indigestion is often difficult to determine but is usually related to inflammation of the peritoneum; "hardware disease" is the most common cause. Hardware disease results when an ingested wire or nail punctures the reticular wall and enflames the peritoneum. If the inflammation is located close to a major nerve branch, it reduces the normal motility of the rumen and the reticulum and thus impairs their function.

Calves are more prone to chronic free-gas bloat than are older animals. There is no obvious association with the type of feed used or with pathological problems. Veterinary experience and observations indicate that physical abnormalities in the positioning of the rumen may occur in this early developmental period. If the attachment of the rumen to the esophagus is not properly aligned, eructation of the gas bubble may be impaired. Animals that exhibit bloat at an early age often outgrow the problem.

Physical obstruction of the esophagus by a foreign object traps the gas in the rumen and causes acute free-gas bloat. Blockages can occur in a

number of ways, but are most common when the animal swallows a large object that does not pass into the rumen. Feeding whole potatoes, beets, carrots, or fruit has caused problems. Pathological growths occurring in the esophagus or rumen and forming a blockage can also cause free-gas bloat.

General clinical findings

Bloat is commonly at fault when an animal dies suddenly or is found dead. Pastured beef cattle are not observed as regularly as dairy cattle and are therefore more likely to be found dead when they suffer from bloat. Feedlot cattle that die as a result of bloat are commonly found dead in the morning, possibly because they are inactive during the night or because they are not observed, detected, and treated. Cattle that are milked and observed regularly may begin to become bloated 15 min to 1 h after they are turned out to a bloat-producing pasture. However, there is commonly a lag of 24–48 h before bloating occurs in cattle that have been placed on a bloat-producing pasture for the first time. They may become bloated on the first day but bloat more commonly occurs on the second or third day. A similar response has been observed in pastured beef cattle that have been on a particular pasture for several days or weeks before bloat occurs. This response is always a surprise to the owner and the veterinarian, who find it difficult to understand why bloat is suddenly occurring on a pasture that has been problem-free for some time.

In pasture (or frothy) bloat, distension is usually more obvious in the upper left flank, although the whole of the abdomen can be enlarged. The animal is uncomfortable and may get up and lie down frequently, defecate often, kick at the belly, and roll over in attempting to relieve the discomfort. Breathing is difficult or labored (a condition known as dyspnea) and occurs through the mouth. The animal protrudes the tongue, salivates, and extends the head. Its respiratory rate is increased to up to 60 inhalation–exhalation cycles per minute. Occasionally, projectile vomiting occurs, and the animal may expel soft feces in a stream. Ruminal movements are usually much increased in the early stages and may be almost continuous, but the sounds are less audible because of the frothy nature of the ingesta. Later, when the distension is extreme, the movements are decreased and may be completely absent. The tympanic note (i.e., drum sound) produced by percussion (tapping on the distended rumen) is characteristic. Before severe bloat (known as clinical tympany) occurs, a temporary increase in eructation and rumination can be noted, but both disappear with severe bloat. Death may occur quickly, but usually does not take place until 2–4 h after the onset of bloat. When the bloat becomes severe enough, the animal collapses and dies quickly, almost without a struggle. Death is likely caused by suffocation, when the distended rumen pushes upon the diaphragm and prevents inhalation.

In a group of affected cattle a number of animals with severe bloat can usually be found, and the remainder have mild to moderate distension of the left flank. These animals are uncomfortable and graze for only short

periods. In dairy cattle, milk production is reduced, perhaps because the animal has reduced its feed intake or by failure of milk letdown.

In free-gas bloat, the excess gas is usually present as a free-gas cap on top of the solid ruminal content (see Fig. 1). As in pasture bloat, an increase in rate and force of ruminal movement in the early stages usually occurs, followed by atony (i.e., weaker or absent activity). Inserting a stomach tube (trocarization) allows the animal to expel large quantities of gas, thus easing rumen distension. An esophageal obstruction can be detected when the stomach tube is passed into the animal.

Pasture bloat

Predisposing factors

Crops

Forages are classified as bloat-causing or bloat-safe, with only a few in the intermediate position, depending on how pastured cattle and sheep respond to them as feed (Table 2). The type of pasture forage used usually determines the risk of bloat. Grasses are usually bloat-safe, but common legumes such as alfalfa and clovers may not be. Several less popular legumes have been pastured intensively without causing bloat.

Table 2 Bloat-causing, low-risk, and bloat-safe forages used as pasture

Bloat-causing	Low-risk	Bloat-safe
alfalfa	arrowleaf clover	sainfoin
sweetclover	spring wheat	birdsfoot trefoil
red clover	oats	cicer milkvetch
white clover	rape	crownvetch
alsike clover	perennial ryegrass	lespedeza
winter wheat		fall rye
		most perennial grasses

The following alfalfa cultivars were tested for bloat potential in cattle and were found to cause bloat: Saranac, Rambler, Washo, Beaver, Thor, Ranger, Roamer, Anchor, Appollo, WL-316, Trumpetor, and Vertus. This test disproved the claim that the creeping-rooted cultivars (e.g., Roamer, Rambler) are bloat-safe.

The bloat-causing potential of crops is related to the ease with which they are digested by rumen microbes. Bloat-causing forages are digested rapidly, whereas bloat-safe forages are digested more slowly (Fig. 6). The low-risk group is intermediate.

Tannins in the plant bind with soluble proteins (foaming agents) and inhibit the activity of rumen microbes. Thus, all tannin-containing forages

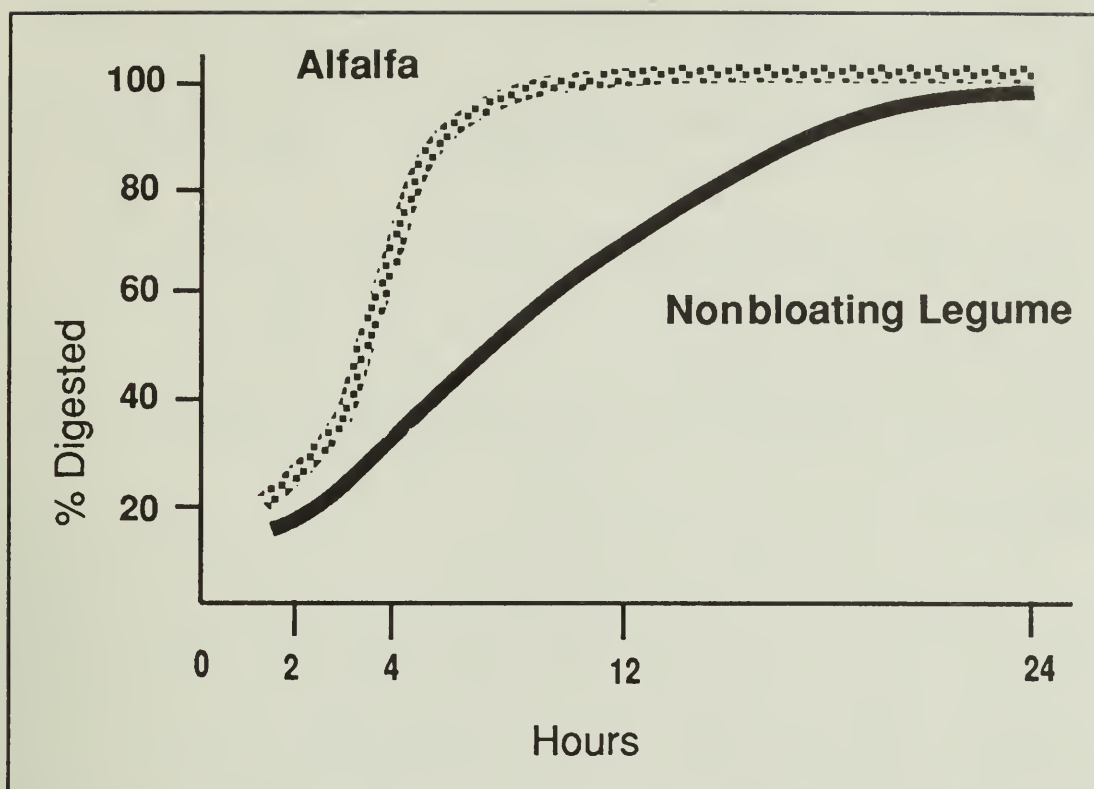


Fig. 6 Association between the bloat-causing potential of legume forages and their rates of digestion by rumen microorganisms.

are bloat-safe. Other bloat-safe characteristics include leaves with thicker, stronger cell walls and veins that prevent rumen bacteria from invading the interior structure of leaves. Conversely, bloat-causing forages have leaves with thin cell walls and low mechanical strength, which make them more vulnerable to invading rumen bacteria.

The Saskatoon Research Station, in cooperation with Agriculture Canada research stations in Lethbridge and Kamloops, has a program to develop bloat-safe alfalfa. Progress has been significant in several cycles of selection, and an alfalfa cultivar with low bloat potential is expected to be released in 1995.

Crop maturity

Crop maturity is the most important factor in preventing pasture bloat. Bloat potency is highest at the vegetative (or prebud) stage, decreasing progressively as the plant grows and matures to full flower (Table 3). At Kamloops, alfalfa that was 20–25 cm high produced double the amount of bloat of alfalfa that was 51–75 cm high. However, plants that were more than 50 cm high still carried a substantial risk of bloat, especially during the first cut.

Table 3 Risk of bloat in cattle fed fresh alfalfa of various heights during five growing seasons

Height of alfalfa (cm)	Probability of bloat* occurrence in the herd (%)	No. of observations (days)
20-25	43	54
26-50	33	360
51-75	22	130

* Bloat is said to occur when one or more animals exhibit bloat on a given day.

Moisture

Bloat historically has been associated with lush growth of pasture forage. Reports of grasses that cause bloating are rare and are restricted to vegetative and lush pastures, where initial digestion rates are high. Alfalfa's potential for causing bloat is highest when moisture conditions are optimal for vegetative growth. Under these conditions, the stems become turgid and fleshy but not fibrous; the leaves are soft and easily crushed between the fingers.

The bloat potential of alfalfa is reduced when soil moisture is insufficient because of either drought or soil salinity. In a given year, the bloat potential of alfalfa was not significantly affected by irrigation that maintained the soil moisture at 50% of field capacity. Given optimum moisture conditions, other weather conditions may influence bloat potential.

Weather

Daily weather records from seven growing seasons (1976-1982) at Kamloops, B.C., were examined to identify relationships between weather conditions and the daily occurrence of bloat. The following parameters were not associated with the frequency of bloat: hours of sunshine, temperature range, precipitation, solar radiation flux,¹ and potential evapotranspiration. Days on which bloat occurred were preceded by lower maximum and minimum temperatures than days on which bloat did not occur, but the temperature difference was small (1-2°C). When yearly averages were compared, bloat was more frequent in dry years than in years of high moisture.

The effect of temperature on bloat potential is complex. Bloat seems to occur when moderate daytime temperatures (20-25°C) permit optimum vegetative growth. Cool overnight temperatures, in combination with moderate daytime temperatures, may induce bloat in the fall. Cool temperatures delay maturation and extend the vegetative growth phase of forage crops, thus optimizing conditions for bloat.

¹ The amount of incoming solar radiation, or heat from the sun.

Cool overnight temperatures (0–10°C) may increase the risk of bloat in the fall. At Kamloops, cattle that were fed alfalfa in October became bloated twice as often as during summer months; this result was observed in 4 different years. At the other extreme, temperatures that are high enough to cause moisture stress and desiccation may reduce bloat potential.

With irrigated alfalfa at Kamloops, no seasonal change in bloat incidence was observed. Bloat occurred in spring, early and late summer, and fall, increasing with cool weather and frost. The fall peak may be caused by frequent heavy dew or fall frost. Under dryland conditions in the Prairie Provinces, peaks of bloat are commonly observed first during the spring flush of growth and then in the fall. After a killing frost, alfalfa has a reputation of being bloat-safe. However, as long as the alfalfa remains green, there is a risk of bloat. A killing frost (–2°C) does not normally damage alfalfa leaves. At Kamloops, bloat continued to occur a month after the first killing frost in November 1979.

Soil type and geographic location

In western Canada, pasture bloat is more frequent in the parkland regions, especially in Gray Wooded soil zones, becoming progressively less frequent in Dark Brown to Brown soil zones. Legume bloat has been reported in 40% of the livestock farms in the Peace River region of northern Alberta.

Many attempts have been made to relate bloat to the mineral nutrition of the plant, generally with conflicting and inconclusive results. The mineral status of the crop is not a reliable predictive factor in the occurrence of pasture bloat.

Summary of plant factors

The greatest risk of bloat occurs during rapid vegetative growth of legume forage. The effects of weather on the incidence of bloat may appear complex but can be understood by relating weather conditions to their effects on plant growth.

Legume pastures might be used more extensively if livestock producers could accurately assess the risk of bloat on a particular legume pasture. Maturity and the moisture content of the legumes are the most reliable indicators of risk, but visual inspection of a legume stand does not provide certain prediction about the risk of bloat.

Animal susceptibility

Animal susceptibility to pasture bloat is considered to be a heritable trait. To determine the feasibility of breeding for reduced animal susceptibility, high- and low-susceptible lines of cattle were selected in a New Zealand study. Although two divergent lines of cattle were obtained, no simple, easily measured physiological trait was found for selection in a

practical on-farm breeding program; it is not practical to test all breeding animals for bloat susceptibility in a direct-feeding test. Nevertheless, it is a good practice to cull known bloat-susceptible animals from a breeding herd.

By feeding fresh alfalfa to rumen-fistulated cattle, it was possible to determine subclinical cases of bloat (i.e., those cases not detected by the usual clinical tests). A subclinical condition was detected in at least one cow for every two cows that showed clinical signs of bloat. The subclinical condition was characterized by frothy rumen content but with no rumen distention or excessive internal pressure.

An animal's predisposition to short-term bloat is related to the condition of the rumen content immediately before feeding. Animals that are predisposed to alfalfa bloat have elevated levels of small particles (see Fig. 3) and microbial activity. Frothiness of rumen content before feeding is common. Approximately 50% of the animals that become bloated after feeding have frothy rumen content before feeding.

As little as 10 kg of fresh alfalfa can provoke bloat in predisposed animals, but a larger feed intake is required to maintain the predisposition. If feed is withheld for 24 h, the levels of feed particles and microbial activity decrease and the predisposition of the rumen disappears. Feeding twice a day for short periods (2–3 h) seems to produce the greatest frequency of bloat. Conversely, unrestricted feed intake may reduce the incidence of bloat. At Kamloops, for example, cattle that were fed fresh alfalfa twice a day (30 kg at 8:30 a.m. and 20 kg at 2:00 p.m.) became bloated three times more often than cattle that were fed alfalfa once a day (50 kg at 8:30 a.m.).

Animal susceptibility to bloat is related to the clearance of small feed particles from the rumen. Frequent bloaters have a slower clearance than nonbloaters, which has been demonstrated in both feedlots and pastures. Susceptibility may also be related to the mineral ion balance (the relative concentration of minerals) in the rumen. A predisposition to bloat appears to be associated with a low concentration of sodium but a high concentration of potassium in the rumen fluid; however, this finding has little practical significance at present.

Prevention of pasture bloat

Choice of forages

Seeding cultivated pastures to grass–legume mixtures is the most effective and least costly method of minimizing pasture bloat, particularly for beef herds grazing over large areas under a continuous grazing system. In a grass–legume mixture, a legume content of 50% is suggested as the maximum bloat-safe level. However, this figure is of limited practical value for large areas, especially on rolling terrain, where it is impossible to maintain a uniform 50:50 stand. If cattle have a tendency to avoid the grass and select the legume, the possibility of bloat increases. Bloat has been reported in mixed pastures where the proportion of legume was less than 15%, possibly because of selective grazing.

Because of alfalfa's potential for causing bloat, some cattle owners avoid seeding this valuable legume. Instead, they use grasses alone or

bloat-safe legumes. Sainfoin, birdsfoot trefoil, cicer milkvetch, and crownvetch are useful bloat-safe legumes in regions where they are adapted. In general, however, their yield, vigor, regrowth, winterhardiness, and persistence are well below those of alfalfa in western Canada.

Seeding grass alone avoids the problem of pasture bloat. However, the benefits of including a legume in the mixture include considerably greater production, higher protein and nutritional value, and lower fertilization costs. A decision to use grass with or without bloat-safe legumes should be based on economic benefits of the greater protein from alfalfa or clover compared with the possible losses from bloat. Although survey statistics are meager, annual bloat losses of cattle that graze legume pastures are generally believed to average approximately 1.5% in western Canada. Experimental comparisons of grass versus legume forages have shown 10–70% increases in animal production from legumes compared with grasses. It is a well established fact that legume forages have a higher voluntary feed intake than most grasses.

Field management

Fertilization and grazing management may be used to maintain a 50:50 mixture of grass and alfalfa. Nitrogen fertilizer and heavy or frequent grazing promote grass growth at the expense of alfalfa. In areas where the incidence of bloat is high, the critical upper limit of alfalfa may be as low as 25–30%. In addition to seeding alfalfa to form 25–30% of the total stand, mixtures grown in sandy areas, which are more prone to drought than are heavy soils, are less likely to produce bloat. Although alfalfa–grass mixtures may be seeded to produce the desired proportion of alfalfa and grass, selective grazing and variation in the terrain of the field may allow excessive intake of alfalfa, resulting in bloat. The period following mechanical harvesting or intensive grazing of alfalfa–grass mixtures may pose a potential risk of bloat, because alfalfa generally recovers faster than grass after cutting.

The ideal companion grass should have the same seasonal growth pattern and regrowth characteristics as alfalfa. Smooth brome grass is widely grown in a mixture with alfalfa, but its regrowth after grazing or cutting is much slower than that of alfalfa. Consequently, pasture bloat may occur when an alfalfa–brome grass mixture is used in rotational grazing systems. Sufficient time must elapse between rotations to allow regrowth of the brome grass.

Sometimes ideal growing conditions at seeding result in a new alfalfa–grass mixture with too much alfalfa. It may then be necessary to defer grazing during the spring flush of growth or to restrict grazing to a portion of the field. Other options are overgrazing or applications of nitrogen fertilizer, which will increase the growth of grass and reduce the proportion of alfalfa in the stand.

A new grass called meadow brome grass has faster regrowth than smooth brome grass. The meadow brome grass cultivars Paddock and Fleet were released from the Saskatoon forage breeding program in 1987.

Because of their fast regrowth characteristics, orchardgrass and timothy are the best choices in areas where they are adapted, such as in eastern Canada. The use of species with faster recovery in pasture helps to reduce the bloat potential of the pastures.

Grazing management

Uniform and regular intake is the key to managing animals on legume pastures. Waiting until the dew is off before placing animals on pasture is a common practice and is probably useful when animals are first exposed to a legume pasture. Before animals are placed on a legume pasture they should be fed coarse hay to satiety. This regimen prevents them from gorging themselves and overeating the fresh and lush legume forage. Thereafter, they should remain on the pasture. The animals may experience mild bloat on first exposure, but the problem should disappear in a few days because animals usually adapt to legume pastures with continuous grazing. If the legume pasture remains highly bloat-potent, the animals should be removed from the pasture until the legume becomes more mature and thus less bloat-potent.

Bloat is often associated with discontinuous grazing, i.e., the removal of animals from legume pastures for a period of time, such as overnight. Similarly, outbreaks of pasture bloat may occur when grazing is interrupted by adverse weather, such as storms, and by biting flies or other insect pests. These factors alter normal grazing habits, generally resulting in more intensive, shorter feeding periods that may increase the incidence of bloat.

A variety of minerals, including phosphate, calcium, and potassium, have been promoted as bloat-control supplements. However, none of the mineral supplements have controlled bloat under experimental conditions.

Antifoaming agents

Oils and detergents are effective for the prevention and treatment of pasture bloat because they break down the frothy condition in the rumen content. Most vegetable oils are effective, but of the various detergents available, only certain types work against rumen foam. Effective detergents are the active ingredients in proprietary products such as Bloat Guard®, which are marketed for the prevention and treatment of pasture bloat. Bloat Guard® contains the antifoaming detergent poloxalene. The daily dose is 4–8 g of Bloat Guard® (2–4 g poloxalene) per 100 kg of body weight, in two daily feedings. It is usually fed as a mixture with a grain supplement. Make sure that each animal receives an adequate level at each feeding by providing enough bunk space for all animals to eat simultaneously.

Many cattle feeders have successfully grazed pure stands of irrigated alfalfa under a rotational grazing system with the use of Bloat Guard®. Success requires careful management of the animals, to maintain uniform feed intake, and field management, to provide a consistent supply of immature alfalfa. For example, rotation from an over-mature field to an immature stand of alfalfa may induce an outbreak of bloat.

In some countries, Bloat Guard® is marketed in salt-molasses blocks and in liquid molasses for use in a lick feeder. Bloat Guard® molasses blocks work best when scattered around the *entire* field at a density of about one block for every 10 head of cattle. The blocks *are not effective* if they are placed near the water supply only. Salt molasses blocks are more effective in small fields than in large ones.

In New Zealand, antibloat detergents are administered to dairy cattle orally at each milking or as a lick applied to the front flank. The flank lick provides only partial protection under conditions of mild bloat.

Antibiotics

Bloat does not develop without a large and active population of bacteria, fungi, and protozoa that break down ingested feedstuffs by microbial fermentation. When antibiotics became available, they were sometimes used to control bloat, based on the principle of reduced microbial activity. Penicillin was the first antibiotic used to control legume bloat, but its use was soon discontinued because of the rapid development of microbial resistance to the drug. More recently, the ionophore antibiotics monensin (Rumensin®) and lasalocid (Bovate®) have been assessed for bloat prevention. The ionophore drugs alter the permeability of microbial membranes, increase ion transport, and change microbial populations in the rumen. Monensin reduced the severity of legume bloat by as much as 73%; this result was attributed mainly to a reduction of protozoal activity in the rumen. Similarly, lasalocid was effective in controlling grain bloat but not legume bloat. The use of salinomycin has produced conflicting results, with some researchers reporting curative effects and others finding it ineffective for bloat control. When used at rates higher than recommended, ionophore antibiotics can be toxic to cattle.

Stored and processed legume feeds

Alfalfa hay

Alfalfa hay combined with cereal grain is probably the most common mixture of dry feed causing bloat in western Canada. Outbreaks of bloat are often associated with particular lots of hay. It is discouraging to discover that a newly purchased lot of alfalfa hay causes bloat, especially if it is the only forage available.

The etiology of alfalfa hay bloat is not as well known as that of feedlot or pasture bloat. Alfalfa hay produces a frothy bloat, the rumen content having a typical viscous consistency and a chronic frothiness. According to the theory of unified bloat, the small feed particles probably come from the alfalfa hay, whereas the cereal grain supplies the readily digestible nutrients for rapid fermentation and gas production.

There is no sure way of predicting the bloat potential of individual lots of alfalfa hay. The best risk indicators are leafy, immature hay, with soft

stems. Hay grown under cool, moist conditions, such as those in the northern parkland, is more likely to cause bloat than hay produced in hot, dry areas. Reports of bloat on damp, moldy hay are common. High protein content alone is not a reliable indicator of bloat risk because the bloat potential is more likely related to the nature of the fiber constituents of the hay. Since fines and leaves are especially dangerous, chopping hay can increase the incidence of bloat.

When alternative roughages are available, a coarse grass hay, cereal grain hay, or straw can be substituted for a portion of the bloat-causing hay. Some dairy producers feed alfalfa hay in the morning and grass hay in the evening in order to watch for bloat during the daytime. Animals should be adjusted gradually to new lots of alfalfa hay; old and new lots should be mixed for the first 5 days of feeding.

Rations containing a 50:50 mixture of alfalfa hay and grain are the most dangerous, but the risk of bloat is low when grain consists of less than 35% of the mixture. When a particular lot of alfalfa hay produces bloat, the problem is not likely to be solved by feeding a different lot of grain. After the cattle adjust to the new hay the frequency of bloat usually decreases.

Other alfalfa feedstuffs

Alfalfa silage and haylage are normally bloat-safe, rarely causing bloat. Processed alfalfa products, such as dehydrated and sun-cured pellets, do not usually present a hazard when they are fed as protein supplements or as replacements for a portion of the cereal grain. Bloat is a risk when alfalfa pellets or cubes are fed in large amounts, i.e., as a substitute for hay, in combination with readily digestible feedstuffs such as grains and molasses. Alfalfa pellets are a source of small feed particles and must be therefore used with caution. Alfalfa cubes, which are compressed but not ground, may be preferable.

Feedlot Bloat

Occurrence

Feedlot bloat occurs most commonly during the finishing period, when cattle follow a diet high in grain and low in roughage. Outbreaks may occur in which a large number of animals are found dead, with no particular warning. In some surveys, feedlot bloat in cattle has been found to be one of the four most common causes of sudden death or of death without the appearance of illness. It is therefore recommended that a veterinarian conduct a postmortem inspection on as many dead feedlot cattle as possible, as soon as possible after death. The tissue changes associated with feedlot bloat are characteristic of animals examined immediately after death. However, if the dead animal is allowed to decompose for more than a few hours, especially during the summer, the tissues degenerate, making an accurate diagnosis of bloat much more difficult.

Causes, predisposing factors, and prevention of frothy bloat

The term feedlot bloat is commonly used in reference to bloat resulting from high-grain–low-roughage rations. The viscous, frothy condition of the rumen content is chronic, and the pH is lower (i.e., more acidic) than in pasture bloat. Feedlot bloat usually occurs after the cattle have been on feed for about 14 days. The high viscosity of rumen content is caused by viscous, extracellular slime that proliferates from rumen bacteria in cattle fed fine-particle-size feed. According to the general theory of frothy bloat, the excess small feed particles come from finely ground feeds. Fine grinding exposes more surface area to rumen bacteria. This process accelerates digestion and creates a rumen condition that subsequently results in extensive rupture of bacterial cells. The ruptured bacterial cells, in turn, contribute to viscosity and frothiness of the rumen.

Feed grains

High-grain diets are often thought to cause bloat. However, experiments conducted at Agriculture Canada research stations with all-concentrate diets (no hay) have shown nearly no incidence of bloat. This bloat-free condition is attributed to feeding coarsely rolled grains. Feedlot operators who change from feeding dry rolled grain with variable amounts of fine-particle-size feed to coarsely rolled grain report a similar reduction in the incidence of bloat. These observations are consistent with our theory that bloat is caused by an abundance of readily digested fine-particle-size feed.

Finely ground grains decrease the pH (and therefore increase the acidity) of the rumen content. Some studies associate the incidence of bloat with a decline in rumen pH. Feedlot operators report that feeding 1% limestone (calcium carbonate) in the grain reduces the incidence of bloat. However, in an experiment using coarsely rolled grain, bloat was not found in diets containing 0–1.4% added limestone. Low calcium level as a factor that causes bloat can be dismissed, because alfalfa has a high calcium content and yet is considered to be a risk factor in bloat.

When a fine-particle-size diet was fed to fistulated cows, a frothy rumen fluid was produced, whereas a coarse-particle-size feed of the same composition produced little or no foam (see Figs. 4, 5). When the animal is digesting the feed, gases produced by rumen bacteria appear to be trapped in the digesta, thus producing the foam that causes bloat. Occasionally, bloat occurs in feedlot cattle even though the grain is coarsely rolled. The incidence is unpredictable and too low to permit research into the cause.

Feedlot bloat may be controlled by the addition of 4% common salt (NaCl) to the diet. Salt may produce its protective effect by increasing water intake and diluting the rumen content. However, the beneficial effect of salt as an additive in concentrate feeds does not persist and should therefore be considered only as a temporary measure when bloat is unexpectedly encountered in the feedlot. Salt also reduces feed intake, resulting in a reduced rate of gain.

Other feeds

Screenings have been associated with outbreaks of bloat, which may be attributed to the fact that screenings are finely ground to form a firm pellet. When the pellet enters the rumen and breaks down, the fine particles are digested quickly, promoting slime secretion and cell lysis similar to finely ground grain. Screenings should be used sparingly in the diet so that a critical level of fine-particle feed is not exceeded.

Moldy feeds may contain a variety of mycotoxins and aflatoxins, which could cause problems and should not be fed under any circumstances. Feedlot bloat is not commonly associated with the feeding of moldy feeds, but such feeds can occasionally cause bloat.

Animals

A considerable amount of foam is formed in the rumen digesta of some animals, even when they are fed either coarse feed or feed containing 4% salt. This finding suggests that differences between animals also contribute to the incidence of bloat; however, the specific animal factors have not been identified. Saliva composition of bloat-susceptible cows differs from that of bloat-resistant cows. The glycoproteins (carbohydrate-containing proteins) of saliva might be useful in indicating bloat susceptibility. This area of research is still under investigation. It appears to be well accepted, however, that animal susceptibility to bloat is a heritable trait.

Causes and prevention of feedlot bloat

The particle size of feed should be examined whenever feedlot bloat is encountered. When feed particles are too fine, nutrients are released too rapidly, which causes fermentation of feedstuffs and allows the proliferation of rumen bacteria to proceed too quickly. The extracellular carbohydrate "slime" that these bacteria produce, and the release of bacterial cell content following lysis, increase the viscosity of rumen fluid. This increased viscosity provides the conditions under which fermentation gases are trapped in the fluid, producing foam; feedlot bloat ensues.

Feedlot bloat is controlled most effectively by maintaining a coarse particle size of feed (see Figs. 4, 5). Coarse particles can be produced by steam rolling or tempering the grain, i.e., adding water to increase the moisture content to about 14% before processing. The grain rollers should be set so that each kernel is only cracked, not rolled out to form a thin disc. In cold weather, the grain should be tempered as it is first being moved out of storage. Experienced operators have found that tempering the grain with unheated water is practical to a level of about -10°C ; below -10°C , tempering should be done with hot water. Keeping the particle size of feed coarse has other advantages over more finely processed feeds, such as greater and more constant feed intake, reduced wind loss, and less irritation from dust to the feedlot operator and the animals.

When bloat occurs a change in the source of feed can often control the bloat. The deletion of beet pulp and molasses can also control bloat immediately.

A number of cattle producers add laundry detergents to feed to prevent bloat. Many testimonials of effectiveness are heard, but no experimental verification exists. Laundry detergents are not registered for use as feed additives, and they therefore cannot be recommended for the control of bloat. Laundry products also contain bleaches, water softeners, corrosion inhibitors, and other components that are not appropriate feed additives and can create other problems for livestock.

Problem-solving

Often an outbreak of bloat occurs for no apparent reason. How does a cattle producer choose appropriate adjustments to management practices or to diet formulation? The traditional models of a bloat-causing regimen, which would normally include legume pastures or high-grain feedlot rations, may not apply in all situations, such as, for example, bloat in calves fed a growing diet with a substantial amount of coarse hay or straw.

In an attempt to provide a solution to the problem of bloat, particularly in cases that are difficult to diagnose, we are presenting a theory to explain the presence of bloat. This theory attributes frothy bloat to an excess of small feed particles in the rumen, in combination with a source of readily digestible feedstuff, that produce rapid fermentation, gas production, and rupture of rumen microflora, the contents of which increase rumen fluid viscosity and thus increase trapped gas.

The suggested approach to solving the problem of bloat is to identify sources of small feed particles and to reduce or eliminate them from the ration. Similarly, sources of rapidly digested feedstuffs (grain, molasses, dries molasses, beet pulp) should be reduced or eliminated from the diet. Sources of small feed particles include finely ground or pelleted feeds, such as hay or grains, or fines from certain locations in feed bins.

Chronic bloaters

Chronic bloat appears in cattle of all ages. The bloat can be life-threatening, but it is generally not as severe as normal bloat. Sometimes it disappears for a few days and then recurs. In mature cattle it is usually associated with chronic hardware disease or an abscess or tumor that interferes with belching. Chronic bloat occurs relatively frequently in beef calves up to 6 months of age, often without an apparent cause. Some possible causes include a condition known as persistent thymus gland in the chest, the continued feeding of poor-quality roughage, and chronic infection of the nerves supplying the forestomachs. However, these causes are not common. In most cases chronic bloat occurs sporadically and is usually due to an abnormality of the belching mechanism. Most animals with chronic bloat should be culled for slaughter if the bloat cannot be controlled by dietary change.

Treatment

Severity of bloat and treatment

The approach to treatment depends on the circumstances in which the bloat occurs, whether the bloat is frothy or free-gas, and whether or not it is life-threatening. There are varying degrees of severity of bloat and a different method of treatment may be necessary in each case (Fig. 7).

In mild bloat the left flank is distended, the animal is not in distress, and 5–7 cm of skin over the upper flank can be easily grasped and “tented” (i.e., lifted). In moderate bloat a more obvious distension of the abdomen is evident, particularly of the left flank, the animal may appear anxious and slightly uncomfortable, and the skin over the upper left flank is usually tight but some can usually be grasped and tented. In severe bloat, gross distension of both sides of the abdomen is evident, especially on the left side, and the animal may breathe through the mouth and protrude the tongue. The animal is usually uncomfortable and may be staggering. The skin over the left upper flank is tense and cannot be grasped and tented.

The livestock producer must often undertake some first-aid measures before professional veterinary attention can be provided. If possible, all animals should be removed immediately from the source of the bloating pasture or feed. In severe cases in which gross distension, mouth-breathing, protrusion of the tongue, and staggering occur, an emergency rumenotomy is necessary to save the animal's life. If the pressure is not released and the animal begins to stagger, it will die within a few minutes.

Many animals have died unnecessarily because owners were unable or reluctant to perform an emergency rumenotomy. It is preferable to have a veterinarian perform an emergency rumenotomy, which is the most drastic method of treatment of bloat. However, if a veterinarian is unavailable the following procedure may save the animal. Using a sharp knife, make a quick incision of the skin, 6–12 cm in length, over the midpoint of the left flank (paralumbar fossa, see Fig. 8). Continue the incision through the skin, the abdominal muscles, and into the rumen. This action will result in an explosive release of ruminal content and marked relief for the animal. It will then be necessary for a veterinarian to irrigate and cleanse the wound, followed by standard surgical closure of the incision of the rumen and the abdominal wall and skin.

Puncturing the rumen with the standard trocar and cannula is much less traumatic than an emergency rumenotomy and has been used by livestock producers and veterinarians for many years for the emergency release of froth and gas in bloat. The standard-sized trocar and cannula (Figs. 9, 10) are usually adequate for the release of gas when the gas cannot be expelled with a stomach tube and when an emergency rumenotomy is not necessary. A small skin incision about 1 cm long must usually be made before the trocar can be inserted through the abdominal wall in the middle of the left paralumbar fossa (see Fig. 8). After inserting the trocar and cannula into the rumen, remove the trocar and leave the cannula in place, allowing the froth or gas to escape. The froth may be viscous, and it may therefore be necessary to insert a piece of wire into the cannula to stir out

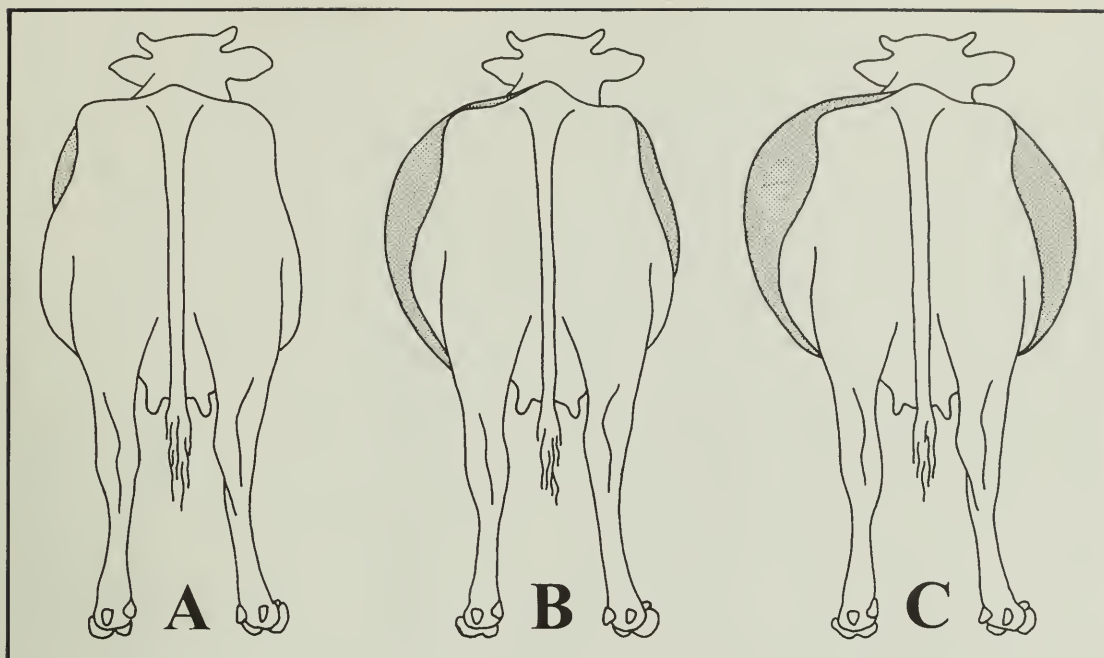


Fig. 7 Three degrees of bloat: A, mild; B, moderate; C, severe.

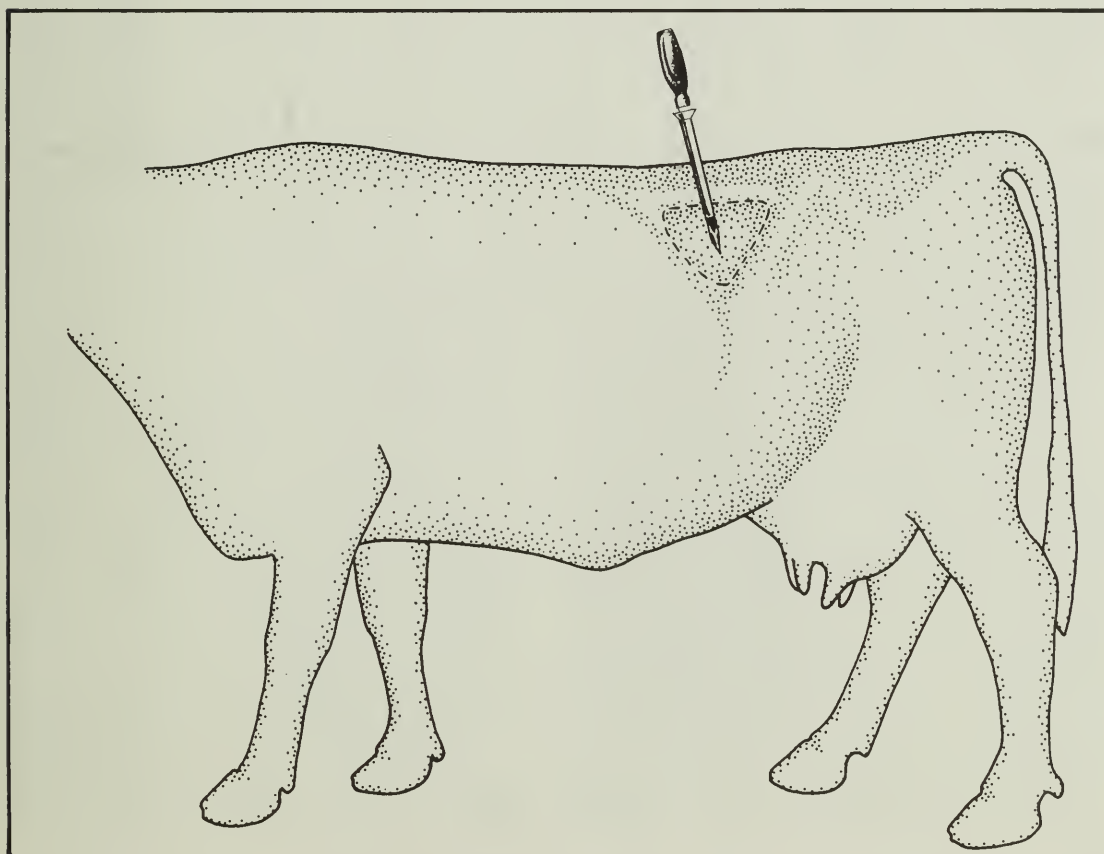


Fig. 8 Location for the insertion of the trocar and cannula. The dotted triangle is the left paralumbar fossa, where in the normal cow the hollow of the flank is found.

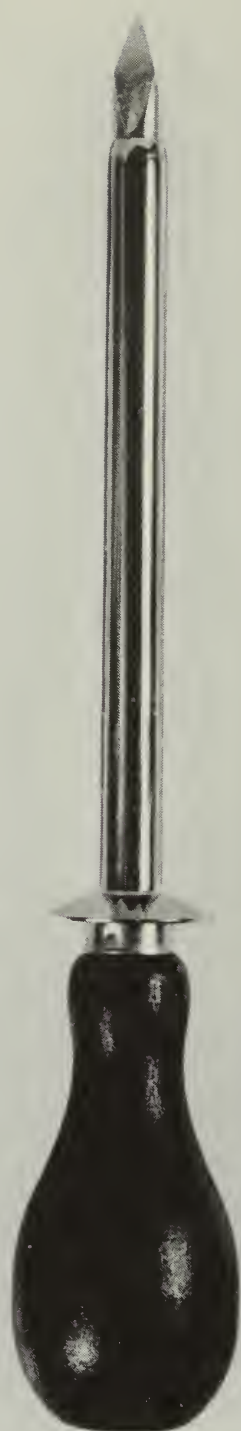


Fig. 9 Standard trocar inserted into cannula.

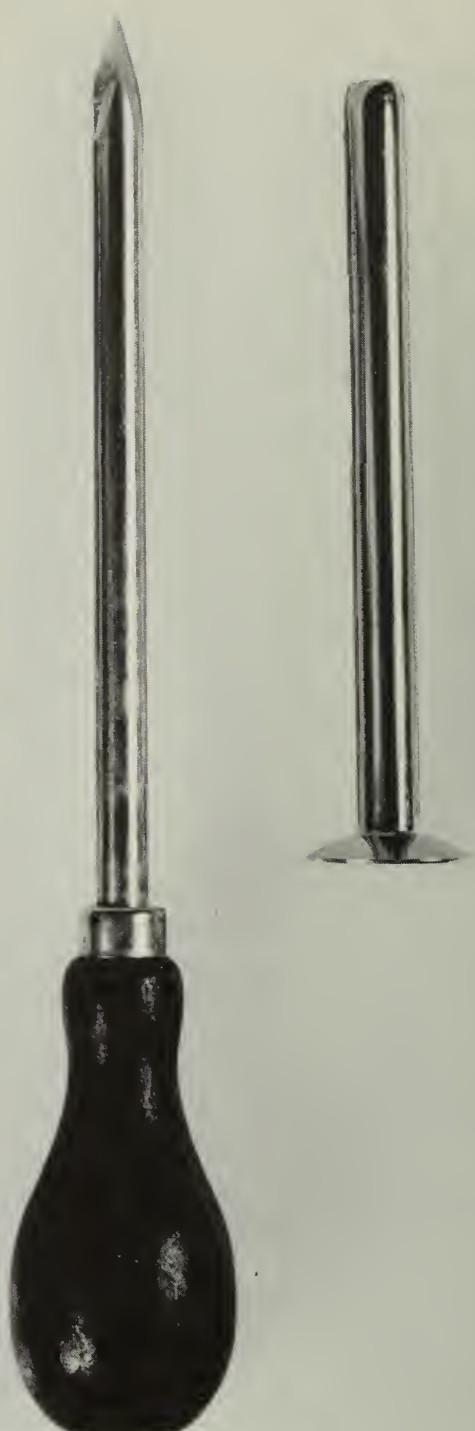


Fig. 10 Standard trocar and cannula taken apart.

the froth. The cannula may be left in place for several hours or even a few days if the bloat persists, with regular observation to ensure that the cannula is not blocked. Antifoaming agents may be administered through the cannula directly into the rumen. The cork-screw type trocar and cannula are also useful when an opening into the rumen is necessary for several days (Figs. 11, 12).

The passage of a stomach tube is recommended when the animal's life is not threatened—that is, when mild to moderate distension of the rumen occurs, the animal is not in distress, and some skin over the flank can still be grasped and tented. However, even in severe cases, the stomach tube should be used first because it is the least traumatic method for the release of rumen gas and pressure. The standard-sized stomach tube (1.5–2.0 cm inside diameter, Fig. 13) is passed through the mouth with the aid of a metal Frick speculum (Figs. 14, 15), which prevents the animal from chewing the tube. With free gas bloat, when the tube enters the rumen, gas is released suddenly, and the ruminal pressure quickly returns to normal, usually in less than a minute.

With frothy bloat the tube commonly becomes plugged by froth immediately upon entering the rumen. The operator should attempt to clear the froth from the end of the tube by blowing through it and moving it back and forth a few centimetres to locate pockets of gas that can be released. With frothy bloat it may be impossible to reduce the pressure significantly with the stomach tube, and an anti-foaming agent should be administered while the tube is in place.

If a standard-sized stomach tube is not available, an automobile heater hose or a garden hose with an outside diameter of 2.0–2.5 cm can be passed through the oral cavity and into the rumen. The metal coupling on a garden hose must be removed to prevent injury to the mucous membranes of the mouth or esophagus. If a Frick speculum is unavailable, the operator will need assistance in holding the mouth partly open so that the animal is unable to chew the tube. When the stomach tube passes through the oral cavity the animal usually swallows it, and the tube thus moves down into the esophagus rather than into the lungs.

If the bloat has not been completely relieved with a stomach tube, but an antifoaming agent has been administered, the animal must be observed carefully for the next hour to determine if the treatment has been successful or if the bloat is becoming worse and more effective measures must be taken.

In an outbreak of feedlot bloat, severe cases must be treated individually, as necessary. There may be many “swellers” with moderate bloat, which will usually recover without treatment if the cattle are walked with force. After a few minutes of walking or running, the gas bubbles migrate to the top of the rumen and animal begins to belch.

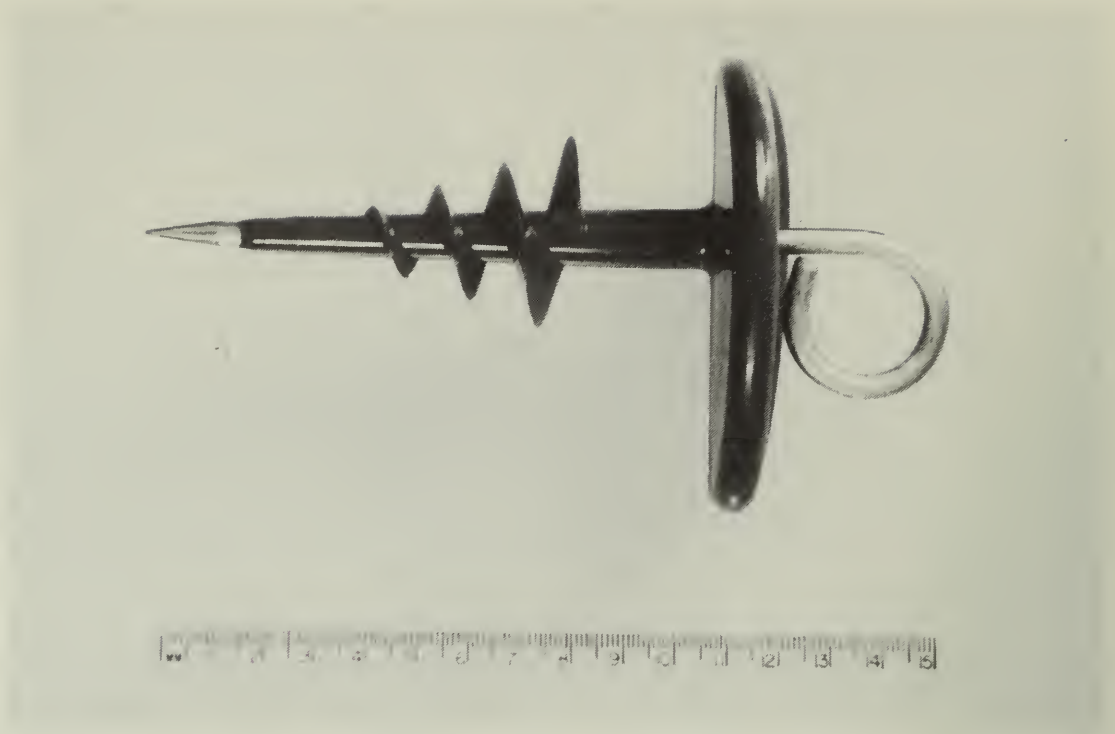


Fig. 11 Corkscrew trocar inserted into cannula.



Fig. 12 Corkscrew trocar and cannula taken apart.

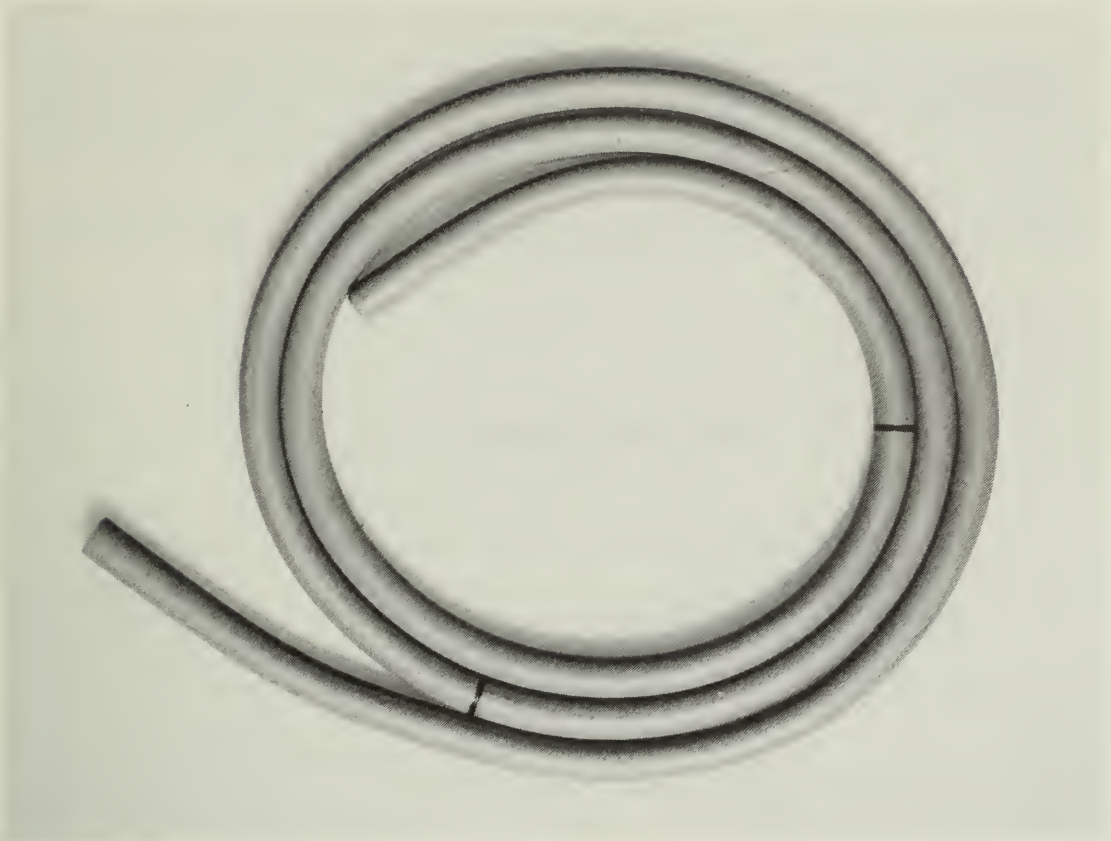


Fig. 13 Standard-sized stomach tube (inside diameter, 1.5–2 cm x 2 m).

Antifoaming agents

Any nontoxic oil, especially a mineral oil that persists in the rumen and is not biodegradable, is effective. The rate for treatment is 300–500 mL (10–12 oz) for a 450 kg (1000 lb) animal, administered in one dose. This treatment can be repeated several times within a few hours if necessary. An emulsified oil or an oil containing an approved detergent such as dioctyl sodium sulfosuccinate is preferred because it mixes better with ruminal contents. The antifoaming agent may be administered with a stomach pump or a large metal syringe directly into the rumen through the stomach tube. The antifoaming agent may also be delivered as a drench, using a standard drenching procedure.

The severity of the bloat usually determines the method of treatment to be used. **Every effort should be made to relieve the gas with a stomach tube, followed by the administration of antifoaming agents through the stomach tube.** If passage of the stomach tube relieves the excess pressure, the antifoaming agent that is administered usually breaks the foam. The animal begins to belch within 10–15 min and recovers within approximately 1 h.

The trocar and cannula method and emergency rumenotomy should be used only when an animal cannot be relieved with the use of a stomach pump and its life is threatened.

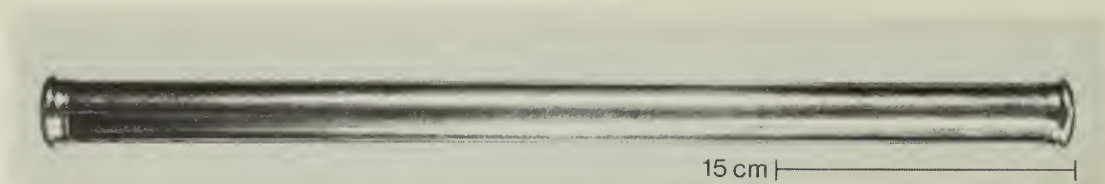


Fig. 14 A Frick speculum, which is used to pass a stomach tube through the oral cavity. The speculum prevents the animal from chewing the tube.

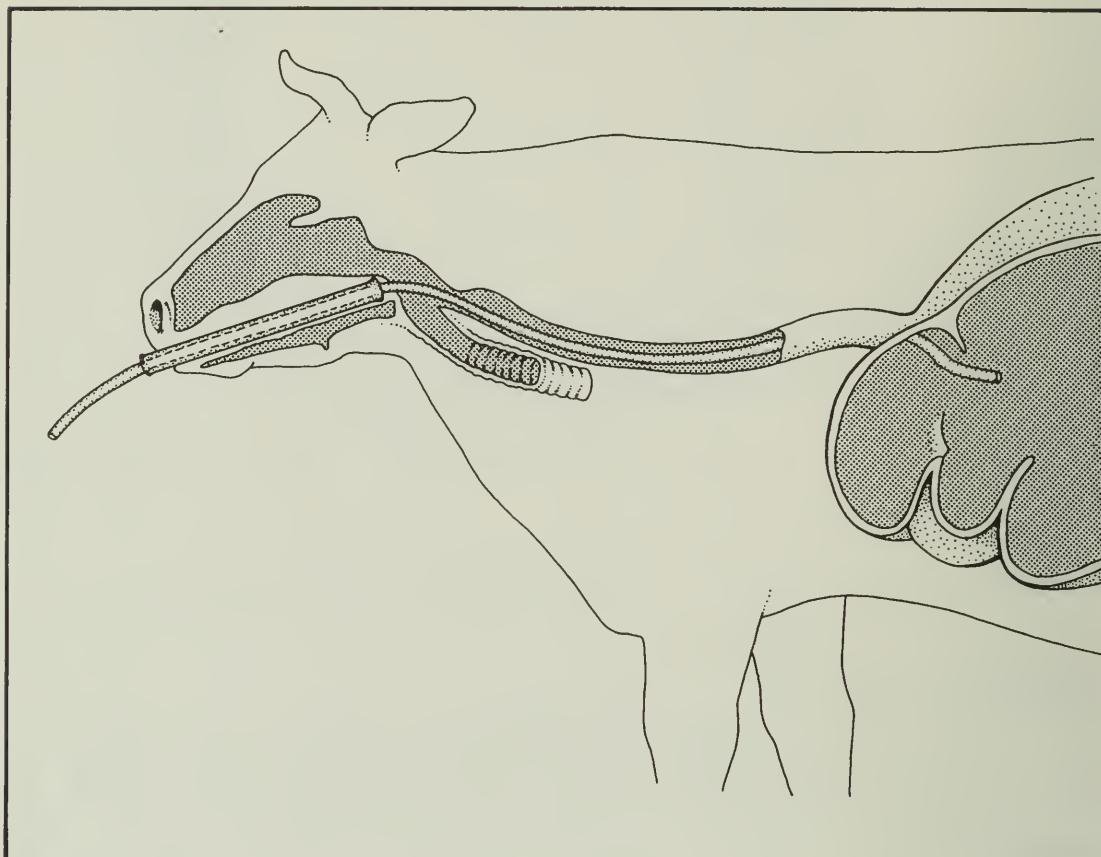


Fig. 15 Position of stomach tube passed through oral passage into the rumen using a Frick speculum.

Common questions and answers

1. *What causes bloat in cattle?*
Bloat in cattle is caused by feeds and diets that provide an excess of fine particles in the rumen in combination with a supply of readily digestible nutrients to support rapid fermentation.
2. *Is there greater risk of pasture bloat at first frost?*
Yes. Frost preserves alfalfa's immature stage of vegetative growth, which is most likely to cause bloat. With a killing frost, the frost disrupts the plant cells that release bloat-causing agents and increases the rate of cell breakdown.
3. *Is bloat associated with soil type?*
Yes. Legume bloat occurs more frequently in Gray Wooded soil zones.
4. *What are the most common bloat-causing forages?*
Alfalfa and clovers.
5. *Does alfalfa silage cause bloat?*
No. The bloat-causing substances (foams) are neutralized by the silage-making process.
6. *Is bloat related to stage of vegetative growth?*
Yes. Lush, immature legume forages are most likely to cause bloat.
7. *How can I tell whether my alfalfa hay will cause bloat?*
You can't tell for sure, but leafy, immature alfalfa hay is more likely to cause a problem than coarse, mature alfalfa hay. Grass hays, especially those that are coarse-textured, are useful for the control of bloat.
8. *Are some cattle more susceptible to bloat?*
Yes. Chronic bloaters and other bloat-susceptible animals should be culled from the herd.
9. *Should household detergents be used to control bloat?*
No, because they often contain corrosion inhibitors and other possible toxic components that can create problems in livestock.
10. *Do mineral supplements control bloat?*
No. None of the mineral supplements (e.g., phosphate, calcium, and potassium) promoted as bloat supplements have controlled bloat under experimental conditions.

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